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Museum.	Number of Busts.		Ratio.
	Sophocles.	Euripides.	
Naples, Museum of Antiquities (portico of celebrated men)	2	3	1:1.5
Rome, Capitoline Museum (hall of celebrated men)	1	3	1:3.0
Average ratio			1:2.25

It is interesting to compare the previous estimates with that of Cattell. In the latter's list of 1,000 most eminent men² as determined by the space method Euripides occupies the ninety-ninth position and Sophocles the one hundred and eighty-first position—the latter being nearly twice as far distant from the first position of eminence as Euripides. While these figures do not allow us to fix the exact ratio of eminence, the relative position of the two poets in degree of renown is indicated unmistakably.

I have applied the space method to a comparison of Sophocles and Euripides, using the histories of Curtius and Grote with the following results:

Historian.	Lines of Space.		Ratio
	Sophocles.	Euripides.	
Curtius	200	773	1:3.86
Grote	38	71	1:1.87
Average ratio			1:2.85

The mean ratio of the averages determined by the five different methods is 1:2.5, the range of value being between 2.1 and 2.9. Notwithstanding, therefore, the overwhelming number of victories which Sophocles achieved over his rival for dramatic excellence, the verdict of mankind seems to be that as far as eminence and fame are concerned Euripides is over twice as renowned as Sophocles.

The method of reference frequency may be applied not only to estimating the position of a man as regards fame, but it may be extended to determining the relative importance of his different achievements. A typical example of the latter is the problem of determining the order of Shakespeare's plays in point of eminence. An index of popular quotations from Shakespeare shows the following order of quotation frequency: first five, Hamlet quoted 191 times, Macbeth 111, Merchant of Venice 68, Julius Cæsar 63, Othello 62; last five, Coriolanus quoted 5 times, Timon of Athens

² *Popular Science Monthly*, 1903, p. 359.

5, first part of Henry VI. 4, Titus Andronicus 3, Pericles 1. The above not only confirms the opinion of Goethe and other critics as regards Hamlet, which excels the other plays of Shakespeare as much as Shakespeare himself excels other dramatists, but it also bears out the general verdict concerning Pericles, which, in the words of White, "is too clumsy, too feeble, too monstrous, too revolting to be an original work of Shakespeare." It would be difficult to find another rapid objective method by which the plays of Shakespeare could be arranged in order of eminence.

Reference frequency of persons, books, works of art, events and all other subjects as determined from indexes to standard works, or indexes of current literature, or library catalogues or other means of reference, constitutes one of the best methods for determining rank in point of celebrity. Its great advantage is the quickness with which one can arrive at the combined judgment of many minds. The method admits of great extension in its manner of application and is recommended to those interested in the pursuit of "historiometric" research.

C. A. BROWNE

SCIENTIFIC BOOKS

Concealing-colors in the Animal Kingdom:

An Exposition of the Laws of Disguise through Color and Pattern, being a summary of Abbott H. Thayer's Discoveries. By GERALD H. THAYER. New York, The Macmillan Co.

By far the most important single contribution that has been made to the much-discussed matter of animal coloration appears under the above title. In an introduction, Abbott H. Thayer, whose "law underlying protective coloration" (1896), with subsequent additions and enlargements, has now become a part of the literature of the subject, and of which the present elaborate volume is the logical amplification, gives a succinct summary of the main features of the book, and outlines the psychological view point from which the succeeding observations are made. An artist of the high-

est attainments, whose whole life is made up of studying the visual aspects of all objects, and with a mind singularly free from preconceived ideas acquired from the study of "cabinet natural history," he is the most authoritative exponent of this phase of nature that could be chosen. Indeed, it has been the lack of this training of the mind through the eye—rather than the reverse operation—that has proved the stumbling-block of such exhaustive students and observers as Wallace and Darwin. Thus it has remained for the painter-naturalist to discover the all-underlying truths of protective coloration. Mr. Thayer and his truly gifted son have spent some eight years in the preparation of this work (which they modestly call an introduction to the study) during which they have unremittingly prosecuted their search for the truth in New England, in the West Indies and in Trinidad. Thus they have had full opportunity to study in nature what they here so lucidly unfold.

Without careful study of this introduction the reader will find it difficult, at times, to take at face value some of the statements which follow in the amplified text. Perhaps the essence of the whole book is this: "Thus, at these crucial moments in the lives of animals, when they are on the verge of catching or being caught, *sight* is commonly the indispensable sense. It is for these moments that their coloration is best adapted, and when looked at from the view point of enemy or prey, as the case may be, proves to be obliterative." Thus an animal may wear a garb vividly conspicuous at most times, when its *senses* may protect it in the open (like the zebra) for the sake of the crucial moments of foaling or drinking in the brush or brakes, when necessarily exposed to the danger of lions or whatever enemy. This of course goes against the accepted theory of natural selection, "which is based on the belief that organisms are susceptible of modification limited only by the duration of the circumstances causing it, or by the attainment of ultimate perfect fitness to environment."

In almost every phase of which the book treats, the direction of inquiry is new, and the authors demand of the reader an open mind, free from preconceptions. This must result, as in all pioneer fields, in the forming of an opposition, armed with an array of "conspicuous" creatures, nearly all of which the authors, with an understanding of the true values of out-doors light and color and environment, find it easy to render if not utterly invisible, at least far from conspicuous. At many out-doors demonstrations given before companies of scientific men, the optical delusions produced—at short distances—by as closely following nature's methods as the painter's artifices could achieve, the invariable result has been the open acknowledgment of mistaking the preconceived for the real appearance of the creature.

Gerald Thayer, in amplifying his father's discoveries, builds up a wonderful structure of new conceptions, most beautifully illustrated with paintings by his father, himself and a number of willing assistants, as well as by a mass of widely and well chosen photographs from nature, contributed by a score or more of naturalists in different parts of the world. The assertion that, in the ultimate, all patterns and colors on all animals will be found to be obliterative at the moment of greatest importance to the wearer is supported by illustration—generally convincing and always beautiful, and often picturing the most conspicuous and bizarre design dissolved in a beautifully true landscape. In the plates showing the wood duck the bird was painted very literally from a mounted bird out of doors, and the delightful setting in each case painted by simply transposing the *exact* color-notes from the bird to their positions in the landscape—a fact which escapes the reader who looks casually at the plates. Thus, too, other of the color-plates are almost sure to be misunderstood if hastily viewed, to the great injustice of the thought with which the book is throughout prepared.

In the first few chapters the general law of gradation is developed with much fullness and

illustration, as it is the basic principle upon which all specialized types of markings must be founded, and without which no picturing of detail, however perfect, would be of any value. Tersely stated, practically all animals—birds, mammals, fishes, insects—are darker above, where they receive most light, and graded lighter and lighter toward their shaded under parts, which are paler or white. Thus the natural and inevitable shadow cast by the solid body upon its own under side is “painted off” in the only possible way, and the reflective shadow comes to nearly or perfectly match the dark, but *lighted* upper surfaces, producing on the whole creature a flat tone, in harmony with its background, upon which may be painted the various detailed devices by which nature seeks to render creatures inconspicuous. A series of models, in the form of birds, makes this all-important principle clear.

In treating the more specialized markings, much emphasis is placed on the importance of highly epitomized semi-distant vistas on the surface of forest-birds, which do not strike the exact focus of the casual eye; an extremely abundant type of marking. Ruptive and seccant markings, interrupting the otherwise conspicuous profile of the wearers, form an important and frequently encountered class, and are treated at some length, as are iridescence and changeable colors. Indeed, this is one of the most delightful and enlightening chapters in this wholly remarkable book.

The chapters pertaining to mammals are the ones that will excite the widest discussion, although most if not all the contentions of the authors must be vindicated if given a full and honest test. While the fact of the high activity of blue has much to do with the success of many of the photographic illustrations in this chapter, the easily demonstrable fact remains that white is the best average match for sky against sky. This has an important bearing with nocturnal species with large white marks on their upper surfaces, seen by prey or enemy against the sky. It is also given as

the reason why all the gulls, terns and other sea birds of the open sky are so largely white: not that they are invisible against the sky, but that white is as near sky-color as anything that can be got, and therefore the best that can be done.

Fishes come in for an elucidating chapter, as do the reptiles, batrachians and invertebrates. Here, especially among the insects, we have the most beautiful and convincing evidence of the close study of the authors, and the wondrous results of it. We are shown by what elaborate means, often entailing the entire reversal of the basic gradation law, nature has managed to overcome the effects of gravity by *counter-grading* such heavy species of caterpillars as by their weight turn the food-leaves edgewise, and thus themselves hang “back-down.” It is significant that the most elaborate adaptation is found during the long senseless and defenceless larval period, when swift motion and keen sight are impossible, and it is certainly among caterpillars that we find the most astounding specific resemblances to exact surroundings. This chapter is one of unbounded interest, and is followed by a discussion of butterflies and moths that is scarcely less exciting.

While the book teems with specific examples of great charm and covers the whole animal kingdom, and is therefore a complete work in one sense, in another it is truly an introduction, as claimed by the authors. For if the reader be himself open-minded, and, fired by the novelty of the discoveries, try for himself the experiments so graphically described, he will be led irresistibly to a sympathy with the enlightened authors, and there will open to him a whole new realm of discovery—he will, in short, be led back to the delightful field of philosophic and contemplative natural history, which, in these days of minute and technical study of classification and relationships, has been nearly if not quite lost sight of. The greatest value of this unusual book lies not, therefore, in the array of specific fact it con-

tains, vast though this be, but rather in its wholly enlightening effect upon the search for biologic truths, and for this alone it is worthy of deep study and a lasting place in literature.

LOUIS AGASSIZ FUERTES

Einführung in die Physiologie der Einzelligen (Protozoen). By S. VON PROWAZEK. Leipzig and Berlin, B. G. Teubner, 1910. Pp. 172.

Ever since the appearance of Verworn's excellent paper on the psycho-physiology of the protozoa in 1889, it has been the hope of many that in these supposedly simple organisms a key would be found to the solution of various perplexing problems in the higher forms; that physiological and psychological processes as well as structures would be discovered here in their very inception. Unfortunately this hope has not been realized. The life processes in the unicellular forms have been found to be exceedingly complex. Even the anatomy is far more complex than was formerly supposed. As a matter of fact the more thorough the investigation, the more intricate and involved the physiology and structure of these apparently simple creatures is found to be. Our author, realizing this, says that a protozoan "is in a certain sense a unicellular metazoan," and the establishment of this idea, he asserts, is the underlying motive of the volume under consideration.

This volume, as the title indicates, is intended to serve as an introduction to the physiology of the unicellular forms. The author says it is not a hand-book. In reality, however, it takes the form of a hand-book and might truthfully be called a very brief review or statement of results of original work bearing on all functional processes in unicellular forms. The principal topics discussed follow in the order of presentation: The structure of the cytoplasm and the nucleus, both physical and chemical; The nature and function of the surface membrane or layer and various organic bodies within the cell; Respiration; Process of feeding; Excretion; Motion and locomotion; Fertilization; Regeneration; Protection; Immunity; Responses to chemicals,

electricity, light, etc.; Inheritance; Variation, and Mutation.

While the results of investigation bearing on some of these topics are fairly conclusive and present some coherence, those bearing on others are quite the opposite and the author's treatment of these necessarily consists mainly of a series of dry incoherent statements of experimental results of interest only to those who are in search of a brief account of the work done and the references to such work.

In general the author's selection and review of papers and his discussion appear sane and trustworthy. He usually presents the literature bearing on both sides of mooted questions without taking a definite stand himself. However, as might be expected in a subject as new as the physiology of the unicellular forms, he supports some conceptions which in the minds of many are erroneous. Among such may be mentioned (1) the idea that the movement of certain amebæ can be accounted for by the effect of the environment on surface tension; (2) the idea that the activity and form of organisms is regulated by a non-energetic principle, an entelechy or a psychoid as described by Driesch; (3) the idea that unicellular forms orient and move directly toward or from a region containing certain chemicals or having a given temperature; (4) the idea that there is no selection of food in the protozoa; (5) the representation of the eye-spot of *Euglena* as a hollow cylinder.

The volume in question will no doubt be found valuable principally as a book of reference. Unfortunately, however, it is not well adapted for this use, owing to the very brief table of contents and the absence of an index, and to the fact that the titles of the papers cited are scattered through the body of the text making it difficult to locate the references referred to. Moreover, the frequent interruption in the text by titles which in many instances appear again and again annoys the reader.

S. O. MAST.

SCIENTIFIC JOURNALS AND ARTICLES

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